

APPENDIX G

Pollen Found at the Delaware Park Site

by

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INTRODUCTION

Pollen is preserved in sediments of terrestrial origin and provides an important indicator of environment, and in some cases, age, in deposits devoid of other fossil material. The best sediments for pollen analysis are those accumulating in lake beds under quiet, highly organic conditions; however, the silts and clays deposited by rivers in flood stage may also contain pollen suitable for analysis. Generally, the amount of pollen recovered from river deposits is considerably less than that recovered from lake bed material. This is the case with the sediments collected at the Delaware Park site. The majority of the pollen grains recovered here probably were introduced into the feature depressions during intermittent, very high spring flooding stages that covered the knoll on which the site is located. Each flooding episode would have left a layer of pollen-bearing silt and clay in the fire pits and midden trenches at the habitation site. Later homogenization due to both weathering and cultural activity would have removed all traces of layering within the features themselves.

Not all pollen recovered from a site comes from plants growing on the site itself. Because pollen is designed for airborne transport, plants located some distance away can contribute to the local pollen profile. This is especially true of the pollen from gymnosperms (pine, fir, etc.), which is large and has two inflated air bladders to aid in transport by wind currents. Thus, the amount of gymnosperm pollen at any given site is usually not in proportion to the number of these plants in the vicinity. However, there are limits on transport distance, and it can be reasonably assumed that any plant pollen found at this site did originate with plants located well within the radius of operations of the inhabitants.

In examining a sediment for traces of pollen, several processing steps must be carried out to preserve the organic material while removing the clay, silt, and rock fragments. The basic method involves treating a given amount of sediment with boiling hydrofluoric acid in order to remove all silicate-based material (clay, silts, and sand), heating this solution with the addition of hydrochloric acid to remove colloidal material, and finally, neutralizing the solution with a base. Distilled water is used throughout to avoid introduction of pollen from the water supply. High-speed centrifuge treatment at each step in the process prevents any pollen from being lost when liquids are decanted. The final residue is brought almost to dryness, and suspended in a known volume of glycerine to which a small amount of dye has been added. Each slide is prepared from a known volume of the glycerine mixture, contained under a glass cover slip. Specimens to be used for reference collections, or which may be transported and kept for long periods of time, are mounted in a permanent mounting medium such as Clearcol, as the simple glycerine preparations dessicate quickly, destroying the pollen. The most important characteristic of this preparation scheme is that an accurate count of pollen per cubic centimeter of sediment may be obtained.

Pollen recovered by this method was examined using the high power (400x) objective of a transmitted light microscope. For each sample, counts were made of every identifiable genus. Lists of genera were prepared for each feature, with the total number of individual grains present recorded. Percentages of the total pollen spectrum were also prepared for each feature. Because these features cannot be located in a definite time-stratigraphic sequence, preparation of pollen curves was not possible, as these are time-series representations. During analysis, special attention was paid to potential environmental indicators and to potential food source plant pollens.

DISCUSSION

Pollen is commonly divided into two basic types - arboreal, or pollen derived from trees, and non-arboreal, or pollen derived from non-woody plants and low shrubs. Spores, which are produced by bryophytes and fungi, are also considered in many pollen counts. Relative proportions of arboreal and non-arboreal pollen, as well as the presence of plants with specific environmental requirements, all aid in interpretation of paleoenvironment. At the Delaware Park site, three major elements have been recognized, distributed in distinct areas of the site and in the surrounding countryside. Localization of these three environments is intimately linked to the topography and underlying geologic materials present. Simply stated, the three plant environments are 1) a mixed deciduous forest, 2) an open ground environment - either meadow or forest openings, and 3) a fresh-water or slightly brackish swamp environment.

1) Mixed deciduous forest: This assemblage is composed of the arboreal pollens recovered from the samples provided. It is dominated by oak and elm, with significant amounts of maple, hickory, and pine. Minor elements of poplar, willow, ash, and what appears to be one of the alder/birch/larch complex are also present. No walnut, beech, or other nut-bearing trees were evident. Significantly absent were Betula nana, the cold-climate species of birch, and Liquidambar, the sweet gum. Also absent was Abies, or fir, and Picea, or spruce.

The types of pollen present, or, perhaps, the types of pollen not present, are good indicators of climate. Oak-hickory forests are indicative of somewhat dry conditions with moderate winters. The presence of elm is also an indicator of moderate winter conditions. However, the absence of sweet gum from this forest complex eliminates the possibility of extremely warm winters. Currently sweet gum and its relatives grow only in the deep south, where winter temperatures rarely remain below freezing for more than a day or two. The presence of pine without spruce or fir indicates a moderate climate as well. Unless cultivated, fir and spruce do not grow south of the New England states today.

The arboreal pollen present in this assemblage does not comprise a major portion of the spectrum. This is indicative of two things - first, that there were large open areas, covered in grasses or non-woody plants, present in the immediate area; and also, that this open parkland environment was probably a result of conditions which were slightly drier than at present. In areas where the climate is warm and dry, tree growth is

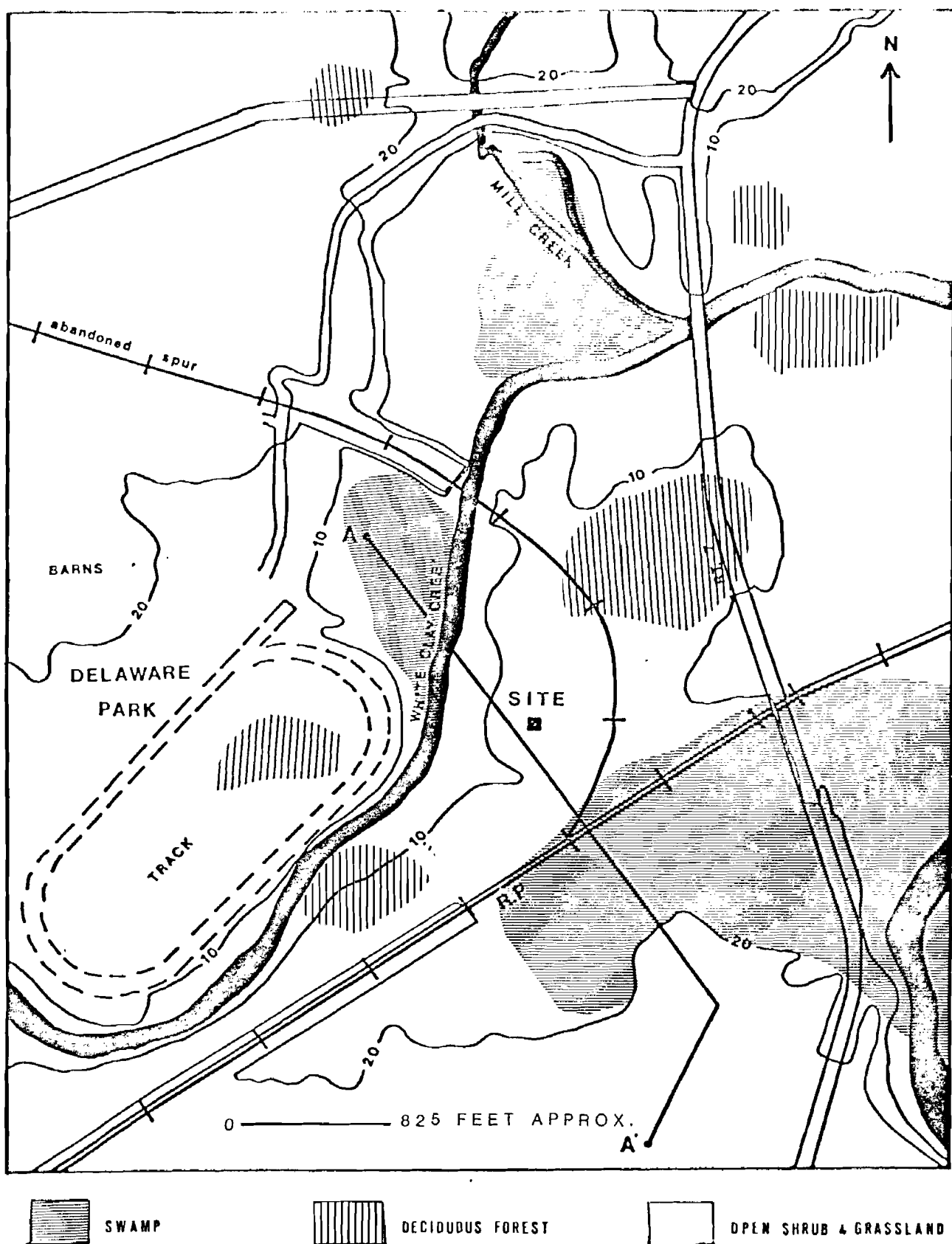


Figure 1 Vegetation Reconstruction For Site Occupation Period
IX-70

generally confined to stream beds or points where the water table is close to the surface. Strictly speaking, the climate present at the time of occupation was not radically different from what might be found during a dry summer followed by a moderate winter in the same area today. However, if this pattern persisted for many years, a gradual and natural deforestation would have taken place, with the forest lands being recolonized by shrubs and herbaceous plants which required less water. Williams (1974) reports a drying and warming trend detectable in lake cores from Indiana which began about 4.5 thousand years ago, and continued until 1.5 thousand years b.p.. Pollen spectra from these lake cores closely parallel those from the Delaware Park site.

2) Open ground environment: This environment is represented by the extremely high percentages of grass and herbaceous plant pollen found in the samples. Next to the grasses, the Compositae and Roseaceae comprise the major part of this assemblage. Compositae are composite-flower plants such as Queen Anne's lace, ragweed, hawkweed, and dandeloin. Ragweed pollen (Ambrosia) was considered separately. This plant is common along both forest verges and in open area. It flourishes in drier conditions than do many other flowering plants, and a high percentage of ragweed pollen may be taken as an indication of dry conditions. The Roseaceae include not only roses and rose-like flowering plants - but also a number of berry-producing plants such as Fragaria, or strawberry. The abundance of pollen of the Roseaceae type would indicate that these open areas probably provided abundant wild berry bushes - blackberry, strawberry, etc., much as the same field areas do today.

Much of the open field or meadow land was probably found on the flood plains surrounding the streams in the area, as well as on the knoll itself. Other fields may have existed on the land to the north of the site, with trees localized immediately adjacent to stream beds, or around springs breaking out at the Fall Line.

3) Fresh-water or brackish swamp: A complete suite of swamp plant pollen was found in these samples. All of the plants identified from their pollen, however, are typical of fresh water, or, at the most, occasionally and mildly brackish water. Typha, the common cattail, for example, can tolerate occasional and mild brackish water conditions. The members of the Chenopodiaceae, however, are exclusively fresh-water plants. The presence of swamps in a drying climate is perfectly acceptable if these swamps are developed in topographic lows near the discharges of major drainage systems. This is the case in the area of the Delaware Park site. The unique topographic position of this site permits the development of large bodies of standing, heavily vegetated water, even though the upland areas were somewhat drier than at present. Vegetational cover would have tended to preserve the wetland nature of these swamps by preventing rapid evaporation. Major spring flooding probably contributed large volumes of water to the swamp areas as streams lost their competence upon emerging into the coastal plain area. Carex, or sedge, which was found in all samples, is a grass-like swamp plant which develops on matted organic materials from previous growing seasons. The presence of Carex indicates both an active vegetational cycle in the swamp areas, as well as continuous nutrient recharge at flood cycles.

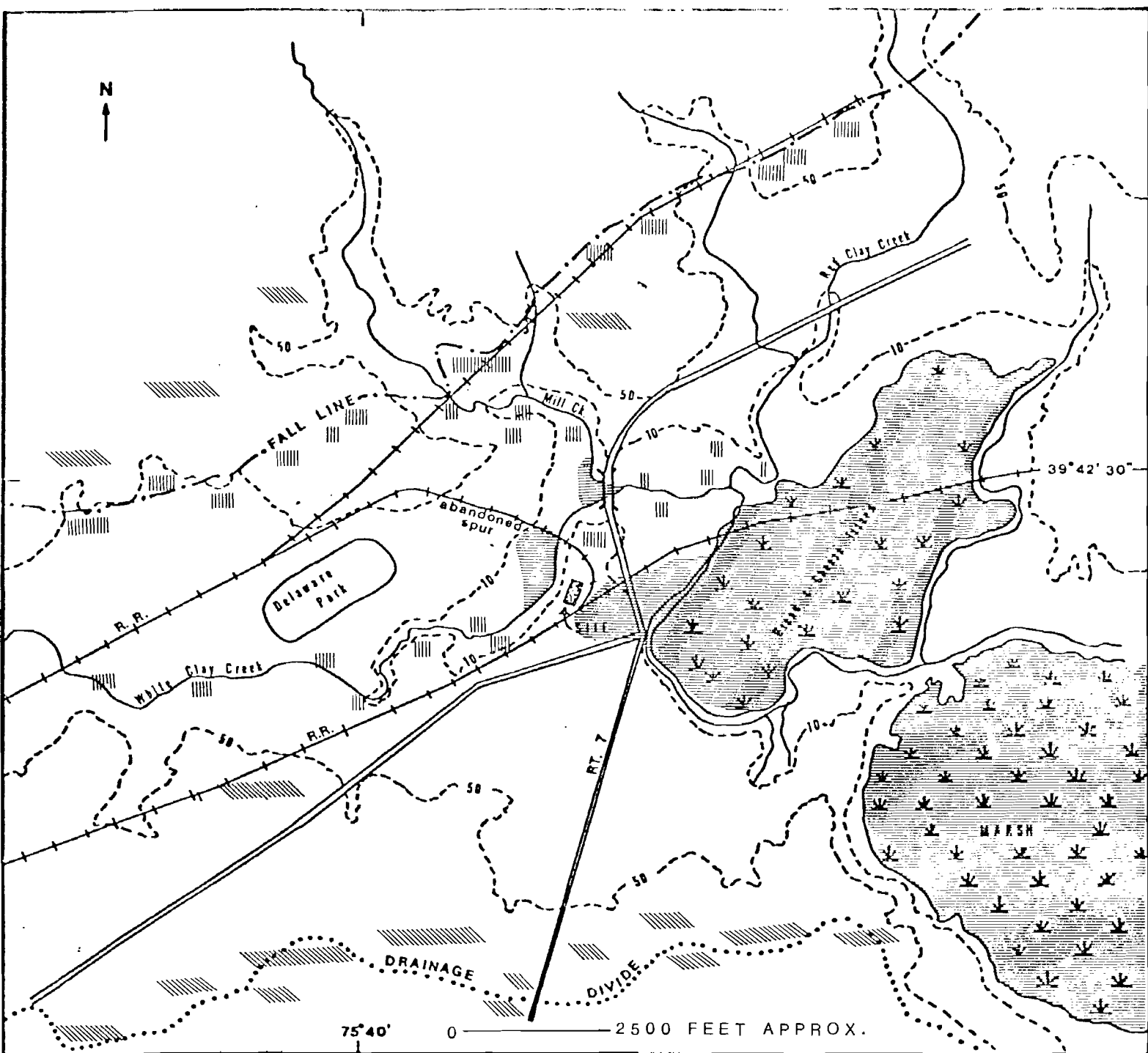


Figure 2 Vegetation Reconstruction For Site Occupation Period

Figure 1 diagrams the probable distribution of these three floral environments in the area of the site. An extended map has been prepared to encompass the entire radius of pollen production which may have contributed to the assemblage. Figure 2 concentrates on the immediate site environment.

Major alterations to the appearance of the site have been caused by cultural activity during and after the colonial period. Agricultural activity has resulted in the deforestation of the entire area. Any trees present today, with few carefully preserved exceptions near historic sites, are second or even third-growth plants. The plowing of many areas for food production has resulted in a relocation of primitive meadowlands, so that their original positions can only be deduced from geologic and topographic evidence. Relative sea level rise, combined with the run-off problems created by intensive farming practices, have increased the rate of silt accumulation in the swamp areas. In the case of those sites immediately next to the habitation area, the swamps have been filled and essentially dried up. Some of this swamp filling may have been deliberate in order to free more land for use. In the area of Bread and Cheese Island, the swamp has been altered to a brackish marsh, with Salicornia and related salt-tolerant genera growing in the low areas, and Typhus in more elevated locations with less salt incursion.

SUMMARY

Pollen studies conducted on a series of grab samples taken in archaeological features at the Delaware Park site near Stanton have provided data for paleoenvironmental reconstruction. Three major floral environments have been recognized - mixed deciduous forest, forest opening, verge or meadow, and a fresh or slightly brackish swamp area. Geologic evidence and present-day topography has been used to plot the distribution of these elements in the area of the site.

The general climate of the area at the time of occupation appears to have been somewhat drier and warmer than at present. The hardwood genera recorded from the site samples compare favorably with those of an assemblage recorded by Williams (1974) from a lake sediment core taken in northeastern Indiana. Her analyses of climate-linked floral changes may be considered equally applicable to the Delaware site, as MacAndrews and King (1976) place northern Delaware and Indiana in the same modern pollen floristic province.

Palynologic evidence for food sources was scarce. Hickory and oak were both noted among the nut-bearing trees. Strawberry and perhaps other related berry plants were also present in the area. Several edible types of field plant such as dock and dandelion contributed minor pollen to the total count. No corn pollen was observed, although there was abundant grass pollen in the assemblage.

| GENERA | FEATURE | | | | | |
|----------------------------------|---------|-----|-----|-----|-----|-----|
| Arboreal Pollen: | 12 | 39 | 43 | 45 | 51 | 56 |
| <u>Pinus</u> | 17 | 16 | 20 | 19 | 16 | 15 |
| <u>Tsuga</u> | 3 | 2 | 6 | 3 | 1 | 1 |
| <u>Juniperus-Taxodium</u> | 6 | 2 | 4 | 6 | 1 | 9 |
| <u>Quercus</u> | 20 | 21 | 29 | 27 | 23 | 21 |
| <u>Ulmus</u> | 16 | 15 | 23 | 24 | 17 | 14 |
| <u>Acer</u> | 5 | 10 | 19 | 18 | 11 | 3 |
| <u>Carya</u> | 2 | 1 | 4 | 5 | 0 | 1 |
| <u>Populus</u> | 2 | 3 | 3 | 1 | 6 | 1 |
| <u>Salix</u> | 1 | 2 | 1 | 1 | 3 | 0 |
| <u>Betula-Corylus</u> | 0 | 1 | 1 | 1 | 0 | 0 |
| <u>Alnus</u> | 1 | 1 | 0 | 3 | 2 | 2 |
| <u>Fraxinus</u> | 0 | 0 | 2 | 0 | 1 | 1 |
| Non-arboreal Pollen: | | | | | | |
| Grasses (Gramineae) | 36 | 50 | 57 | 60 | 51 | 40 |
| Roseaceae | 7 | 9 | 14 | 11 | 10 | 5 |
| Compositae (no <u>Ambrosia</u>) | 11 | 6 | 13 | 8 | 6 | 10 |
| <u>Ambrosia</u> | 10 | 11 | 18 | 9 | 8 | 15 |
| <u>Rumex</u> | 5 | 6 | 14 | 9 | 3 | 1 |
| Campanulacea | 3 | 4 | 6 | 3 | 1 | 2 |
| Chenopodiacea | 11 | 12 | 15 | 18 | 10 | 16 |
| <u>Nyssa</u> | 5 | 6 | 9 | 8 | 4 | 4 |
| <u>Carex</u> | 14 | 9 | 20 | 16 | 8 | 10 |
| <u>Typha</u> | 15 | 10 | 16 | 11 | 19 | 11 |
| <u>Plantago</u> | 7 | 10 | 15 | 5 | 2 | 5 |
| Spores: | | | | | | |
| Ferns | 6 | 0 | 1 | 0 | 0 | 1 |
| <u>Selaginella</u> | 1 | 0 | 0 | 1 | 2 | 2 |
| <u>Equisetum</u> | 1 | 0 | 2 | 1 | 1 | 1 |
| TOTAL POLLEN & SPORES | 202 | 205 | 314 | 269 | 207 | 192 |

Table 1: Raw counts of pollen and spores, listed by feature number

| GENERA | FEATURE | | | | |
|---------------------------|---------|----|-----|-----|-----|
| Arboreal Pollen: | 63 | 94 | 138 | 149 | 194 |
| <u>Pinus</u> | 20 | 18 | 26 | 21 | 4 |
| <u>Tsuga</u> | 5 | 2 | 10 | 8 | 1 |
| <u>Juniperus-Taxodium</u> | 7 | 5 | 9 | 6 | 0 |
| <u>Quercus</u> | 30 | 25 | 39 | 32 | 1 |
| <u>Ulmus</u> | 25 | 18 | 40 | 20 | 0 |
| <u>Acer</u> | 16 | 10 | 10 | 9 | 0 |
| <u>Carya</u> | 9 | 3 | 11 | 7 | 0 |
| <u>Populus</u> | 5 | 5 | 3 | 7 | 0 |
| <u>Salix</u> | 5 | 0 | 8 | 6 | 0 |
| <u>Betula-Corylus</u> | 1 | 1 | 2 | 3 | 0 |
| <u>Alnus</u> | 2 | 4 | 2 | 0 | 0 |
| <u>Fraxinus</u> | 0 | 2 | 0 | 4 | 0 |

Non-arboreal Pollen:

| | | | | | |
|--------------------------|----|----|----|----|---|
| Grasses (Gramineae) | 63 | 36 | 75 | 49 | 6 |
| Roseaceae | 15 | 9 | 16 | 8 | 0 |
| Compositae (no Ambrosia) | 20 | 7 | 21 | 7 | 0 |
| <u>Ambrosia</u> | 16 | 14 | 25 | 13 | 0 |
| <u>Rumex</u> | 10 | 3 | 12 | 7 | 0 |
| Campanulacea | 7 | 6 | 8 | 5 | 0 |
| Chenopodiacea | 20 | 9 | 25 | 11 | 0 |
| <u>Nyssa</u> | 9 | 5 | 11 | 6 | 0 |
| <u>Carex</u> | 14 | 8 | 20 | 5 | 0 |
| <u>Typha</u> | 20 | 18 | 26 | 11 | 2 |
| <u>Plantago</u> | 9 | 15 | 13 | 14 | 0 |

Spores:

| | | | | | |
|--------------------|---|---|---|---|---|
| Ferns | 6 | 2 | 9 | 0 | 0 |
| <u>Selaginella</u> | 3 | 1 | 5 | 1 | 0 |
| <u>Equisetum</u> | 4 | 0 | 1 | 1 | 0 |

| | | | | | |
|-----------------------|-----|-----|-----|-----|----|
| TOTAL POLLEN & SPORES | 344 | 227 | 427 | 262 | 14 |
|-----------------------|-----|-----|-----|-----|----|

Table 1 (cont.): Raw counts of pollen and spores, listed by
feature number. IX-76

POLLEN TYPE

FEATURE

| | 12 | 39 | 43 | 45 | 51 | 56 | 63 | 94 | 138 | 149 | 194 |
|--------------------|------|------|------|------|------|------|------|------|------|------|------|
| Gymnosperm | 12.9 | 9.8 | 9.6 | 10.4 | 8.7 | 13.1 | 9.3 | 11.1 | 10.5 | 13.4 | 35.7 |
| Hardwoods | 23.3 | 26.3 | 26.1 | 29.7 | 30.4 | 22.4 | 27.0 | 29.9 | 26.9 | 33.6 | 7.1 |
| Grasses | 17.8 | 24.4 | 18.2 | 22.3 | 24.6 | 20.8 | 18.3 | 15.9 | 17.6 | 18.9 | 42.9 |
| Herbaceous plants | 21.3 | 22.9 | 26.1 | 17.1 | 14.9 | 20.3 | 23.3 | 24.2 | 22.3 | 21.0 | 00.0 |
| Wetland indicators | 20.8 | 16.6 | 19.1 | 19.7 | 19.8 | 21.3 | 18.3 | 17.6 | 19.2 | 12.6 | 14.3 |
| Spores | 3.9 | 0.0 | 1.0 | 1.0 | 1.0 | 2.0 | 4.0 | 1.0 | 4.0 | 1.0 | 00.0 |

Table 2: Pollen percentages by type and feature number

ARBOREAL POLLEN:

| | |
|--------------------|-----------|
| <u>Abies</u> | fir |
| <u>Acer</u> | maple |
| <u>Alnus</u> | alder |
| <u>Betula</u> | birch |
| <u>Carya</u> | hickory |
| <u>Corylus</u> | hazel |
| <u>Fraxinus</u> | ash |
| <u>Juniperus</u> | juniper |
| <u>Larix</u> | larch |
| <u>Liquidambar</u> | sweet gum |
| <u>Picea</u> | spruce |
| <u>Pinus</u> | pine |
| <u>Populus</u> | poplar |
| <u>Salix</u> | willow |
| <u>Taxodium</u> | yew |
| <u>Tsuga</u> | hemlock |
| <u>Ulmus</u> | elm |

NON-ARBOREAL POLLEN:

| | |
|----------------------|---|
| <u>Ambrosia</u> | ragweed |
| <u>Campanulacea</u> | family containing harebell, bellflower |
| <u>Carex</u> | sedges |
| <u>Chenopodiacea</u> | fresh-water swamp plants |
| <u>Compositae</u> | family containing ragweed, dandeloin, daisey |
| <u>Gramineae</u> | grasses, wheat, oats, etc. |
| <u>Nyssa</u> | water hyacinth |
| <u>Plantago</u> | plantains |
| <u>Roseacea</u> | roses, strawberries, blackberries, hawthorn, plum |
| <u>Typha</u> | cattail |
| <u>Rumex</u> | dock |

Table 3: Common names of plant types mentioned in text or charts

SELECTED POLLEN PERCENTAGES FROM FEATURES AT 7NC-E-41

| <u>Feature</u> | <u>Date</u> | <u>Grasses</u> | <u>Herbaceous</u> | <u>Wetland</u> | <u>Total NAP</u> * | <u>Pine</u> | <u>Oak</u> | <u>Elm</u> | <u>Hickory</u> |
|----------------|-------------|----------------|-------------------|----------------|--------------------|-------------|------------|------------|----------------|
| Fea. 63 | AD 640 | 18.3 | 23.3 | 18.3 | 59.9 | 5.8 | 8.7 | 7.2 | 2.6 |
| Fea. 51 | AD 455 | 24.6 | 14.9 | 19.8 | 59.3 | 7.7 | 11.1 | 8.2 | 0.0 |
| Fea. 39 | AD 275 | 24.4 | 22.9 | 16.6 | 63.9 | 7.8 | 10.2 | 7.3 | 0.4 |
| Fea. 56 | AD 100 | 20.8 | 20.3 | 21.3 | 62.4 | 7.8 | 10.9 | 7.2 | 0.5 |
| Fea. 45 | AD 85 | 22.3 | 17.1 | 19.7 | 59.1 | 9.8 | 14.0 | 12.5 | 2.6 |
| Fea. 43 | AD 80 | 18.2 | 26.1 | 19.1 | 63.4 | 6.3 | 9.2 | 7.3 | 1.2 |
| Fea. 12 | AD 65 | 17.8 | 21.3 | 20.8 | 59.9 | 8.4 | 9.9 | 7.9 | 0.9 |
| Fea. 149 | 10 BC | 18.9 | 21.0 | 12.6 | 52.5 | 8.0 | 12.2 | 7.6 | 2.6 |
| Fea. 138 | 740 BC | 17.6 | 22.3 | 19.2 | 59.1 | 6.0 | 9.1 | 9.3 | 2.5 |
| Fea. 94 | 1850 BC | 15.9 | 24.2 | 17.6 | 57.7 | 7.9 | 11.0 | 7.9 | 1.3 |

* Non-arboreal pollen

** Table 4. Selected Pollen Percentages

** Table 4 has been added to this Appendix by the Principal Investigator. Credit for it should be given to Dr. Jay Custer, consultant.

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